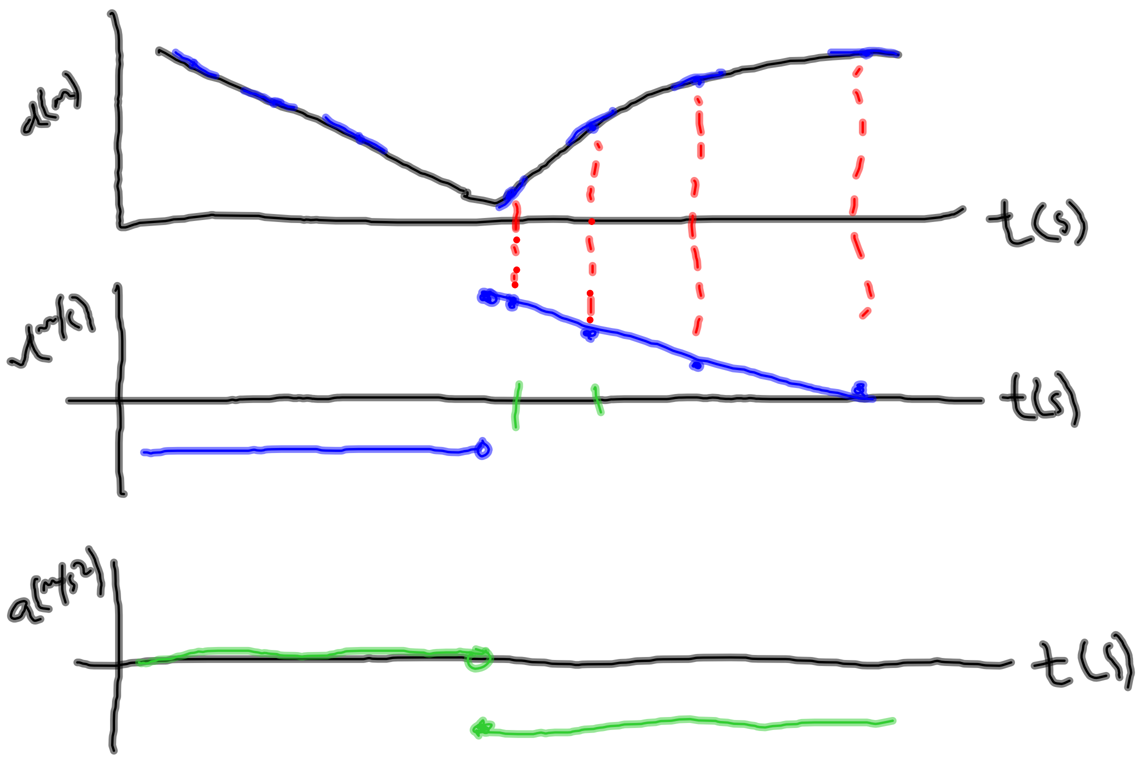
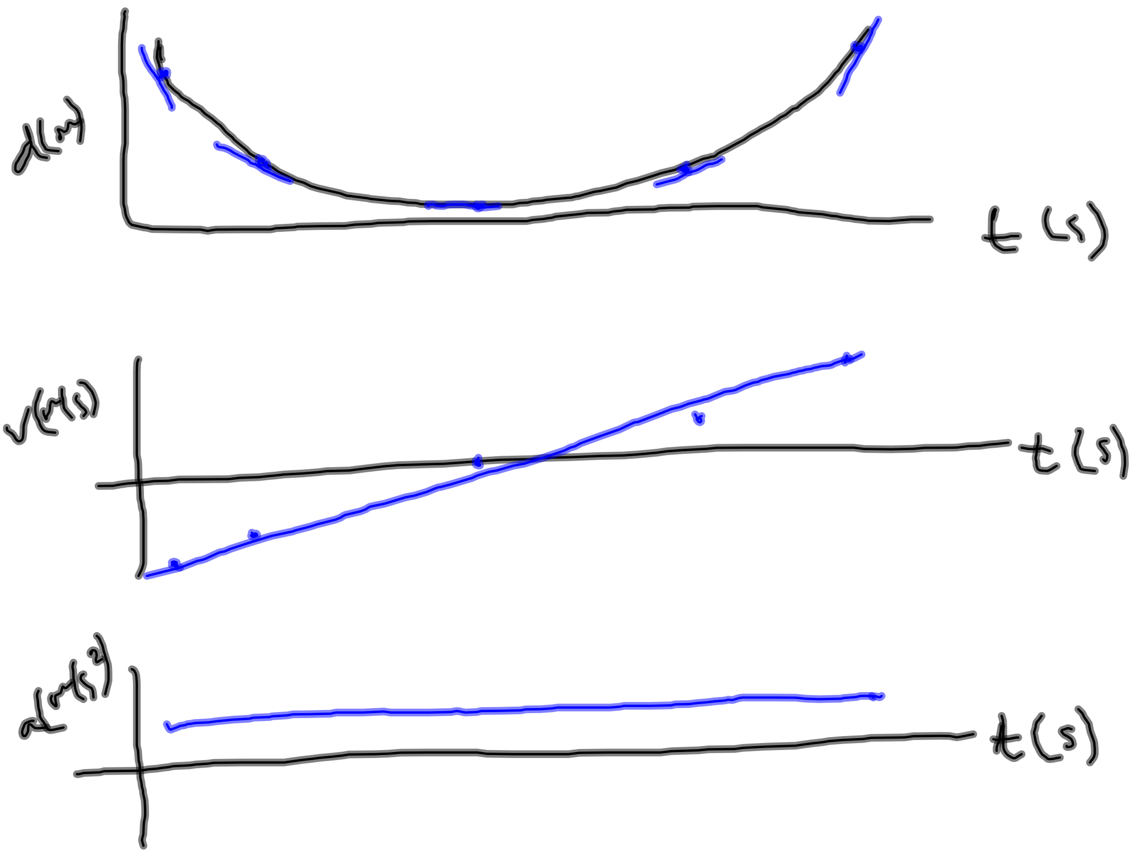
**Kinematics Equations and Practice Problems 1.30.12 CP Physics**




d(m)
t (s)
v(m/s)
t (s)
a(m/s²)
t (s)

| velocity | acceleration | motion of object |
| --- | --- | --- |
| + | + | speed up |
| − | − | speed up |
| + | − | slow down |
| − | + | slow down |
| − or + | Ø | constant speed |
| initial Ø | − or + | speeding up from rest |
| Ø | Ø | not moving |

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# Kinematics Equations:

$\Delta x$ → displacement (change in position)

$v_i$ → initial velocity

$v_f$ → final velocity

$t$ → time

$a$ → acceleration

$$\Delta x = v_i t + \frac{1}{2} a t^2$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$v_f = v_i + at$$

A car is traveling on the highway at 35 m/s when he sees the light ahead of him turn red. If it takes him 4.35 s to stop in 582 m, what was his acceleration?

35 m/s → $v_i$

stop → 0 m/s → $v_f$

4.35 s → t

582 m → $\Delta x$

a → ?

We can solve with two equations.

$$v_f = v_i + at$$

$$a = \frac{v_f - v_i}{t}$$

$$= \frac{0\ m/s - 35\ m/s}{4.35\ s}$$

$$= -8.04\ m/s^2$$

A plane starting at rest at one end of a runway undergoes a uniform acceleration of 4.8 m/s/s for 15 s before takeoff.
a) What is its speed at takeoff?
b) How long must the runway be for the plane to be able to take off?

$v_i = 0 \text{ m/s} \quad a = 4.8 \text{ m/s}^2 \quad t = 15 \text{ s}$

$v_f = ? \quad \Delta x = ?$

a) $v_f = v_i + at$

$= 0 \text{ m/s} + (4.8 \text{ m/s}^2)(15 \text{ s})$

$= 72 \text{ m/s}$

b) $\Delta x = v_i t + \frac{1}{2}at^2$

$= \cancel{(0 \text{ m/s})(15 \text{ s})} + \frac{1}{2}(4.8 \text{ m/s}^2)(15 \text{ s})^2$

$= 540 \text{ m}$

A car accelerates uniformly in a straight line from rest at the rate of 2.3 m/s/s.
a) What is the speed of the car after it has traveled 55 m?
b) How long does it take the car to travel 55 m?

$v_i = 0 \text{ m/s} \quad a = 2.3 \text{ m/s}^2$

a) $\Delta x = 55 \text{ m} \quad v_f = ?$

$v_f^2 = v_i^2 + 2a\Delta x$ ($v_i^2 \to 0$)

$v_f = \sqrt{2a\Delta x}$

$= \sqrt{2(2.3 \text{ m/s}^2)(55 \text{ m})}$

$= 15.9 \text{ m/s}$

b) $v_f = v_i + at$

$t = \dfrac{v_f - v_i}{a}$

$= \dfrac{15.9 \text{ m/s} - 0 \text{ m/s}}{2.3 \text{ m/s}^2}$

$= 6.91 \text{ s}$

$-at = v_i - v_f$

$t = \dfrac{v_i - v_f}{-a}$

$= \dfrac{v_f - v_i}{a}$

## Walking Activity:

- 1 paper per group
- Measure t (everyone times) and $\Delta x$
- Must start at rest or finish at rest
- Calculate acceleration
- 2x per person